Stream Discharge

Lesson Abstract

Summary:	Students will determine the amount of stream discharge in cubic feet per second.
MO GLE:	SC4.1.D.6,5.1.A.6, 5.3.A.6, 7.1.A.6
Subject Areas:	Science, Mathematics
Show-Me Standards:	Goals – 1.6, 1.10 Strands – SC 1, 2, 5, 7; MA 1
Skills:	Addition, subtraction, multiplication, division, measurement of width and depth
Duration:	Field trip (2 hours in field)
Setting:	Shallow stream (2 feet deep or less)
Key Vocabulary:	Gradient, velocity, cubic feet per second (cfs), discharge

Rationale:

- Students will apply mathematical concepts to real life situations involving water usage.

Student relevance:

- The calculation of discharge is used to determine the beneficial use of a stream.
- Streams may be useful as municipal water supplies or for irrigation.
- Discharge calculations are also used for flood control information and to determine the requirements for wastewater treatment plants that discharge into streams.
- The amount of discharge of a stream affects its usage.

Learning Objectives:

Upon completion, students will be able to . . .

- Collect field data.
- Calculate the flow and cross-sectional area of a stream.
- Determine the suitability of the stream water use applications.

Students Need to Know:

- Addition, subtraction, and division.
- How to measure with a ruler.
- How to measure with a tape measure.

Teachers Need to Know:

- River/stream discharge has a direct impact on resource use.
- How to calculate stream discharge.
- The volume of water flowing within a stream is called stream discharge.
- Stream discharge is the product of the stream's mean velocity and its cross-sectional area.
- Prior to determining stream discharge, all stream velocity and cross-sectional area measurements must be taken and all calculations for velocity and cross-sectional area must be completed.
- Discharge is expressed in cubic feet of water flowing past a given point along the stream per second, or simply cubic feet/second (cfs).
- A cubic foot of water is equal to 7.48 gallons of water. It can be represented as a container one foot wide, one foot long, and one foot high.
- If the discharge of a stream is one cubic foot/second (cfs), then 7.48 gallons of water flow past a point every second.
- Total gallons are often the most useful unit in explaining discharge to a general audience.
- Calculation for discharge, in cfs, is determined by cross-sectional area of stream multiplied by the mean velocity of stream.
- Total gallons of discharge per second are determined by the discharge, in cfs, multiplied by 7.48 gallons.

Resources:

The following are available from the Missouri Department of Natural Resources, Division of Geology and Land Survey, P.O. Box 250, Rolla, MO 65402, (573)368-2125.

Water Use of Missouri Water Resources Report No. 48 ($12 plus shipping)
Water Atlas of Missouri ($10 plus shipping)

The following are available at no charge from the Missouri Department of Conservation, P.O. Box 180, Jefferson City, MO 65102-0180, (573)751-4115.

Fishing for Answers: The Challenge of Conserving Aquatic Resources, 1991
Fishing for Answers: Teacher's Edition, 1991

Water Quality Monitoring Notebook, Level One (available with volunteer water quality training workshop)

Materials Needed for Lesson:

Field site consideration: water should be no more than knee deep on students
100' survey tape (50' or 25' will work)
Practice whiffle Golf Ball (plactic)
Measuring stick (measured in .1 foot increments) or a dowel rod marked off in .1 foot increments with a permanent marker
Stopwatch or watch with a second hand
Stream Discharge Activity (handout)

Procedure:

- Discuss the different sizes of rivers and how they are used based on their size (for example, barge travel versus inner tube travel).
- Using the *Stream Discharge Activity* handout, first model the procedure for stream discharge in the classroom using hypothetical measurements.
- Generate at least three fictional data sets and graph the flows using the scientific inquiry method with the dependent and independent variables.
- Then determine actual discharge at three points on a designated field trip site.

Evaluation Strategies:

- Allow groups of students to measure flow and compare results.
- Based on data collected and graph outcomes, write a paragraph summarizing the results and then discuss appropriate and inappropriate stream uses.
- Performance Task: You are the engineers for a new dam. With the data you have determined in the activity (cfs), how long would it take to fill a community lake? Determine the size (depth and area) of the lake, then show and explain your calculations.

Extension Activities:

- Inventory stream usage within a local watershed. Compare and contrast stream usage and discharges (or relative sizes).
- Compare stream flow discharge to that of other rivers in Missouri using the *Missouri Water Atlas* or *Water Use of Missouri*.

Suggested Scoring Guide:

	Points Possible	Points Earned
1. Statement of hypothesis	10	
2. Graph:		
a. Proper Title	10	
b. Axes drawn and labeled	10	
c. Dependent variable and units labeled	10	
d. Independent variable and units labeled	10	
e. Appropriate scale	10	
3. Summary of Results	10	
4. Participation in discussions	10	
5. Stream Discharge Activity	10	
6. Performance Task	10	
Total Points Possible	**100**	

Stream Discharge Activity

Directions: Follow the steps below using the designated materials.

1. Measure and mark a 100-foot distance along a straight section of the stream (if you cannot find a straight 100-foot section, use 10', 25' or 50').

2. Place an practice Whiffle golf ball (or a stick 5-6" long) in the water at the upstream marker.

3. Record the number of seconds it takes for the Whiffle ball to float between the stakes.

4. Divide the 100 feet (or 50 feet or 25 feet) by the number of seconds.

5. Do this three times and use the average time.

   1st 100 feet divided by _____ seconds = _____ feet/second

   2nd 100 feet divided by _____ seconds = _____ feet/second

   3rd 100 feet divided by _____ seconds = _____ feet/second

   Total _____ feet/second divided by 3 = _____ feet/second Average

6. Find the average width of the stream: Measure width of the stream at three places within the 100-foot area, then divide the total by three to get the average width.

7. Find the average depth of the stream: Measure depth of the stream in three places across the stream in a straight line, then divide the total by four to get the average depth of the stream.

   _____ feet plus _____ feet plus _____ feet = _____ divided by 3 = _____ feet
   1st 2nd 3rd Total Average width

   Note: The reason you take three depth measurements and divide by four is to take into account the shallow areas of the stream. For example, if depth in three places is A(.5'), B(.8'), and C(.5', total (1.8'), average depth is determined by dividing by 4: 1.8'/4=.45', the correct average depth.

8. Find the cubic feet of water/second: Multiply the average width, average depth, and number of feet/second. A cubic foot is water in a container one foot wide by one foot high by one foot long, or 7.48 gallons.

   _____ feet x _____ feet x _____ feet/second = _____ cfs
   Ave. width Ave. depth Velocity Rate of flow

9. To determine total gallons, multiply cfs by 7.48 gallons.